APPENDIX J – CLAY BARRIER INVESTIGATION

FINAL REMEDIAL INVESTIGATION REPORT
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

Prepared By: URS Corporation

TABLE OF CONTENTS

1.0 INTRODUCTION J-1
1.1 Purpose of the Investigation J-1
1.2 Scope of the Investigation J-1
2.0 METHODOLOGY J-2
2.1 Detailed Approach J-2
2.1.1 Contractors and Subcontractors J-3
2.1.1.1 Principal Contractor – URS Corporation J-3
2.1.1.2 Surveying Subcontractor – Pacific Engineering, Incorporated J-3
2.1.1.3 Drilling Subcontractor – Gregg Drilling & Testing, Incorporated J-3
2.1.1.4 Laboratory Subcontractor – PTS Laboratories, Incorporated J-3
2.1.2 Equipment and Tools J-3
2.1.2.1 Geo-referencing Software J-3
2.1.2.2 Surveying Equipment and Software J-4
2.1.2.3 Drilling and Sampling Equipment J-4
2.1.2.4 Physical Properties Testing Equipment J-4
2.2 Deviations from RI/FS Work Plan J-4
3.0 INVESTIGATION RESULTS J-6
4.0 EVALUATION OF ADDITIONAL DATA NEEDS J-8

LIST OF TABLES

Table #	Description
J-1	Aerial Photographs Used in Clay Barrier Investigation
J-2	Survey Coordinates of Clay Barrier Limits
J-3	Depth and Elevation to Top of Clay Barrier
J-4	Summary of Physical Properties Test Results

LIST OF FIGURES

Figure #	Description
J-1	August 1981 Aerial Photograph with Interpolated Limits of Clay Barrier
J-2	Detail of Interpolated Limits of Clay Barrier and Coordinate Locations
J-3	Soil Boring Locations and Cross Section Locations
J-4	Cross Section A-A' Along Clay Barrier
J-5	Cross Section B-B' Through Gallery Well

LIST OF ATTACHMENTS

ATTACHMENT J-1 HISTORICAL AERIAL PHOTOGRAPHS
ATTACHMENT J-2 SOIL BORING LOGS
ATTACHMENT J-3 LABORATORY REPORT – PHYSICAL TESTING OF CLAY BARRIER MATERIALS

LIST OF ACRONYMS

CSC	Casmalia Steering Committee
DQO	data quality objective
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Technologies
ft	feet
GIS	Geographic Information System
GPS	global positioning system
P/S Landfill	Pesticide/Solvent Landfill
PID	photoionization detector
ppm	parts per million
PTS Laboratories	Petroleum Testing Services Laboratories
R.G.	Registered Geologist
RI/FS	Remedial Investigation/Feasibility Study
RICH	RI Change Form
URS	URS Corporation

1.0 INTRODUCTION

The Casmalia Steering Committee (CSC) completed the Clay Barrier Investigation in accordance with the June 2004 *RI/FS Work Plan* and the May 2006 *Final Spring 2006 Phase II RI Sampling Plan*, both of which were prepared by the CSC and submitted to the EPA. The following sections describe the nature and findings of the work completed as part of this investigation.

1.1 Purpose of the Investigation

In general accordance with the scope of work described both in Section 5.2 of the RI/FS Work Plan, entitled *Proposed Methodology for Determining the Elevation of the Top and Lateral Limits of the Clay Barrier*, and discussed in RI Change Form (RICH) 012.2, the CSC conducted office analyses and follow-up subsurface investigations to determine the position and limits of the clay barrier, generally known to be situated below the southern terminus of the pesticide/solvent landfill (P/S Landfill) just south of the Gallery Well (Figure J-1). Specifically, this investigation was conducted to define the elevation of the top of the clay barrier, confirm the actual position and alignment of the barrier, and to determine the physical characteristics of the barrier material so that this information could be used in future evaluations to assess the effectiveness of the clay barrier as a containment feature for Gallery Well liquids.

1.2 Scope of the Investigation

The Clay Barrier Investigation involved completion of several sequential tasks, as further described below. Estimated limits of the barrier were first established through a review of historical aerial photographs and then surveyed-in and staked in the field. Drilling and soil sampling was then conducted within the estimated barrier limits to confirm the elevation and alignment of the barrier, and to collect representative samples of the barrier materials for laboratory testing of physical properties. Further discussion of the contractors and subcontractors used, the detailed methods employed, and findings and conclusions of the Clay Barrier Investigation are presented in the following sections.

2.0 METHODOLOGY

2.1 Detailed Approach

The CSC examined historical color aerial photographs from August and December 1981 for evidence of the clay barrier alignment (Table J-1 and Attachment J-1). As can be seen in the historical aerial photographs in Attachment J-1, the barrier alignment is clearly visible at the ground surface on both the August and December 1981 photographs as a west-northwest to east-southeast trending dark gray lineament, or surface trace, that contrasts strongly with the surrounding tan to buff colored native soils in this area. The lateral limits of the barrier were then established by geo-referencing the August 1981 historical photograph to the most currently available Site topographic map (April 2004) using ArcView® geographic information system (GIS) software, then deriving the northing and easting positions at 14 selected points along the margin of the feature from the current topographic base map, effectively defining the "envelope" within which the clay barrier was thought to lie. Geo-referencing was performed by identifying fixed physical site features common to both the August 1981 and March 2004 aerial photographs and using these to properly scale and align these photographs.

The northing and easting coordinates derived from this geo-referencing exercise were then provided to a licensed surveyor, who in turn located and staked the position of 14 points surrounding the clay barrier alignment, as interpreted from the historical aerial photograph analysis (Figure J-2). Prior to initiation of drilling activities, URS field personnel visited the off-site borrow area used as the source of earth materials used in construction of the clay barrier in order to visually examine and obtain representative samples of these materials for comparison with materials encountered in the exploratory borings along the anticipated barrier alignment. Small drilling pads were prepared by leveling the ground surface in selected locations along the anticipated barrier alignment using a small track-mounted excavator and/or front loader in order to provide a stable platform for drilling equipment. An initial five hollow-stem auger soil borings were completed at selected locations along the inferred barrier alignment in an effort to confirm tha alignment of the barrier, as well as to define the depth, and thus elevation, of the top of the clay barrier. Because initial exploration at boring location RICLB-01 encountered only a thin section of clay barrier material, an additional boring (RICLB-01A) was completed nearby in an effort to confirm findings from this initial boring. Initial soil boring locations were selected to provide broad spatial coverage along the length of the anticipated alignment (Figure J-3). In response to EPA comments presented in their September 26, 2005 letter to the CSC, three additional soil borings were subsequently completed along the barrier alignment to collect representative samples of the barrier materials for laboratory testing of physical properties.

Initial soil borings were completed to total depths of between 22 and 46 feet below ground surface (bgs) on October 14 and 15, 2004. Continuous sampling was conducted from depths of approximately 10 feet bgs to the total depth of each initial boring by completing repeated 18-inch sampling runs. The three follow-up soil borings were completed to total depths of between 25.5 and 50 feet bgs on August 27-28, 2006. Drilling of these follow-up borings involved collection of continuous core using a four foot-long core barrel, beginning at between approximately four to 12 feet above the top of the barrier (as defined in initial borings) and extending several feet into the barrier material. Once within the barrier, discrete 2.5-foot long Shelby tube samples of the barrier materials were collected from each of the three follow-up borings. Shelby tubes were hydraulically pushed beginning at between 2.5 and five feet into the barrier, and extended to depths of approximately five to 7.5 feet into the barrier.

All soil borings were logged by a URS geologist, and the materials encountered were examined to confirm they were consistent with the materials used in construction of the clay barrier.

2.1.1 Contractors and Subcontractors

The CSC contracted URS Corporation (URS) to complete the Clay Barrier Investigation. URS subcontracted support services used to survey and stake estimated barrier limits and completed borehole locations, complete the drilling activities used to confirm the position of the barrier, and perform laboratory testing of barrier material physical properties. The specific work completed by each party is further described below.

2.1.1.1 Principal Contractor – URS Corporation

URS coordinated and oversaw all aspects of the Clay Barrier Investigation. URS staff performed the office aerial photograph analysis and geo-referencing exercise, coordinated the surveying of estimated barrier limits by the land surveyor subcontractor, and directed all drilling and soil sampling activities conducted as part of this investigation.

2.1.1.2 Surveying Subcontractor – Pacific Engineering, Incorporated

All field surveying and demarcation activities were subcontracted to Pacific Engineering, Incorporated of Santa Maria, California (now Cannon Associates). All surveying activities were conducted under the direct supervision of a California registered civil engineer (Leroy Cadena, California registered civil engineer No. C55373). Using northing-easting coordinates provided by URS, Pacific Engineering located and staked the estimated lateral limits of the clay barrier on the ground surface. Completed boring locations were also surveyed.

2.1.1.3 Drilling Subcontractor – Gregg Drilling & Testing, Incorporated

All drilling and soil sample collection activities were subcontracted to Gregg Drilling & Testing, Incorporated of Signal Hill, California. Gregg Drilling is a licensed California drilling contractor (California C57HIC license No. 485165). Gregg Drilling used a track-mounted hollow stem auger drilling rig to complete all boreholes used in defining the elevation and alignment of the clay barrier.

2.1.1.4 Laboratory Subcontractor – PTS Laboratories, Incorporated

Laboratory testing of barrier material physical properties was conducted by PTS Laboratories of Santa Fe Springs, California. PTS is a specialty laboratory focused upon providing testing services for soil and rock physical properties, core analysis, bench scale testing and field sample handling services to the environmental, engineering, construction and petroleum industries.

2.1.2 Equipment and Tools

2.1.2.1 Geo-referencing Software

Geo-referencing of features observed on historical (1981) and current (2004) aerial photographs was conducted on a desktop personal computer using ArcView 3.2A® GIS software. Image

scaling and warping was completed using ImageWarp Extension 2.0®, derived from the ESRI web site (*http://arcscripts.esri.com/details.asp?dbid=10118*).

2.1.2.2 Surveying Equipment and Software

Surveying of interpreted clay barrier limit coordinates was completed using Global Positioning System (GPS) equipment. Location coordinates were loaded into a TDS Ranger 200C® data collector running SurveyPro® with robotic and GPS software. Coordinate locations were located and staked in the field using a Thales G-Max® real time kinematics dual frequency GPS rover and base system. Staked coordinate locations are reported to a lateral accuracy of 0.033 feet, and ground surface elevations are reported to a vertical accuracy of 0.065 feet. Control points used in field surveying were the same as those used to create the most recent Site topographic map (April 2004).

2.1.2.3 Drilling and Sampling Equipment

Drilling was conducted using a Marl M35 or 5MT track-mounted drill rig equipped with 6-inch diameter hollow-stem augers. Soil sampling for the initial five soil borings was conducted using an unlined, 2-inch diameter, 18-inch long modified California split-spoon sampler, whereas soil sampling for the three follow-up soil borings was conducted using a four-foot long, 2.25-inch diameter stainless steel macrocore core barrel. Representative samples of the barrier material were collected into steel Shelby tubes by hydraulically pushing them into the barrier to collect relatively undisturbed samples the barrier material for physical testing purposes.

2.1.2.4 Physical Properties Testing Equipment

Physical testing of barrier materials was performed by PTS Laboratories. Testing equipment is maintained and calibrated in accordance with manufacturer specifications, and operated in accordance with the PTS's Quality Assurance Manual. Instruments, equipment and methods used to determine grain size gradation and hydraulic conductivity are common to all materials testing laboratories, and included the use ovens, scales, sieves, and permeameters. Apparatus and methods used for performing the various physical tests were performed in accordance with American Society for Testing and Materials, and/or American Petroleum Institute guidelines. Test methods for physical testing included ASTM Method D422/D4464M for grain size gradation and ASTM Method D5084 for hydraulic conductivity.

2.2 Deviations from RI/FS Work Plan

As agreed to with EPA, the methods used in completing the Clay Barrier Investigation differed from those originally described in the Section 5.2 of the RI/FS Work Plan. Deviations from the RI/FS Work Plan are described below.

- An aerial photograph review and geo-referencing analysis was conducted in lieu of performing horizontal drilling to define the alignment of the clay barrier;
- Vertical drilling along the anticipated alignment to define the elevation of the top of the clay barrier was completed using hollow-stem auger drilling equipment instead of direct-push drilling methods;
- A total of eight borings were completed as part of the Clay Barrier Investigation instead of the three proposed in the RI/FS Work Plan; and

- Laboratory testing of barrier material physical properties was conducted by PTS Laboratories, instead of Geosyntec's Atlanta, Goergia soil lab.

Deviations from the RI/FS Work Plan are described in RICH-012.2, dated October 19, 2004, and initial borings were performed in accordance with these revisions. With the exceptions noted above, follow-up boring were completed as outlined in the May 2006 *Final Spring 2006 Phase II RI Sampling Plan*.

3.0 INVESTIGATION RESULTS

As noted above, historical aerial photographs that the CSC reviewed in establishing the estimated limits of the clay barrier are identified in Table J-1. Selected physical Site features visible in the August 1981 photograph (which provided the best orientation and location of the clay barrier) were geo-referenced to the same features visible in aerial photographs of the Site taken during March 2004 used to create the most recent Site topographic base map (April 2004). Site features observed in both photographs and used in the geo-referencing exercise included the maintenance shed, two above-ground water storage tanks situated near the northern limit of the Site, and a clearly defined turning point along the eastern Site fence line. Once these photographs were registered as accurately as possible, the northing-easting coordinates of 14 points defining the "envelope" within which the clay barrier was anticipated to lie were derived from control provided by the April 2004 topographic map of the Site. These locations were then staked in the field by surveyors from Pacific Engineering, Inc. to demarcate the anticipated alignment of the clay barrier. The coordinates derived from the geo-referencing exercise and used in defining the clay barrier envelope are summarized in Table J-2.

As discussed with EPA, URS geologists observed examples of the borrow material used for construction of the clay barrier (these observations indicated that the clay materials were comprised of a very dark gray to black, hard adobe-type clay containing small rootlets and small pale brown claystone fragments). Agency oversight personnel accompanied URS staff in making these borrow material observations. A representative sample of the clay barrier borrow material was collected and brought to drill site for reference and comparison with earth materials encountered during subsurface exploration.

Each of the eight borings completed during the Clay Barrier Investigation encountered materials consistent with those reported to have been used in construction of the barrier, and similar to those observed in the clay barrier borrow area. The nature of clay barrier materials encountered in the borings was very similar from boring to boring, comprising very dark gray to black, stiff to highly plastic clay, containing trace sand-sized light yellowish brown claystone fragments and organics, typically fine root fibers. Barrier materials encountered in the soil borings contrasts strongly with typically yellowish-brown, grayish-brown and olive brown, fractured claystone materials known to surround the barrier, and are considered unmistakable relative to these other materials. Copies of soil borings logs completed during the Clay Barrier Investigation are presented in Attachment J-2.

Table J-3 summarizes total boring depths as well as depths and corresponding elevations of the top of the clay barrier as interpreted based upon the nature of subsurface materials encountered during drilling. Figure J-3 illustrates the location of cross sections along and through the clay barrier, and the cross sections presented in Figures J-4 and J-5 graphically summarize the findings of the Clay Barrier Investigation, depicting soil boring locations, total completion depths, ground surface elevation and the top of the clay barrier as encountered in the borings completed. As illustrated in these figures, the clay barrier lies along a north-northwest to east-southeast alignment, and its top lies at depths ranging from approximately 16 feet bgs at the eastern end of the barrier (boring RICLB-01A) to approximately 42 feet bgs at the western end (boring RICLB-07), corresponding to elevations of approximately 515 to 528 feet (Table J-3).

Three discrete samples of clay barrier material were collected into Shelby tubes from a depth interval ranging from 2.5 to eight beneath the top of the barrier from soil borings RISSCL-07,

RISSCL-08, and RISSCL-09. Results of laboratory physical properties testing for these three representative samples indicate barrier materials comprise between 75.6% and 90.75% silt & clay size particles, with a mean particle size in the silt range for all samples. Fine sand represented between 9.25% and 24.0% by weight, with no measurable medium or course sand or gravel particles. Hydraulic conductivity values measured in these samples range from 2.7E-08 to 4.3E-08 centimeters/second. Copies of laboratory reports for physical properties testing of barrier materials are included as Attachment J-3, and results are summarized in Table J-4.

4.0 EVALUATION OF ADDITIONAL DATA NEEDS

While data quality objectives (DQOs) have been established for many elements of the RI, no DQOs exist for this specific activity. Because the Clay Barrier Investigation was successful in defining the alignment and top elevation of this feature, as well as the physical properties of the barrier material, the objectives for this task as stated in the RI/FS Work Plan and Final Spring Phase II Sampling Plan have been met; therefore no additional work is necessary.